2008
Allegheny National Forest
Hemlock Woolly Adelgid
Survey

Equipment needed:

- GPS Unit
- Compass
- Maps and Datasheets

About the plan:

This plan was developed at the Entomology Research Laboratory at the University of Vermont. It is statistically based so that the reliability of estimates can be defined yet it is relatively straightforward in its execution and flexible enough to accommodate various sampling goals.

This sampling plan was created using national forest stand data. Only stands defined as "hemlock" were considered and a subset of those stands with road access were selected.

About the insect:

Native to Japan, the hemlock woolly adelgid (*Adelges tsugae*) (HWA) is a pest of eastern hemlock (*Tsuga canadensis*) and Carolina hemlock (*T. caroliniana*), both of which are considered highly susceptible to the adelgid, with no documented resistance. The latter tree species is found only in the southern region of the Appalachian Mountains. The HWA is currently established in 16 Eastern States from Georgia to Maine. Tree decline and mortality have increased at an accelerated rate since the late 1980s. In the Shenandoah National Park, hemlock crown health has declined since the early 1990s. When sampled, greater than 77 percent of the hemlocks sampled were in an "excellent" condition; by 2000, less than 5 percent were in an "excellent" condition. A 2001 statewide survey of hemlock stands in New Jersey showed that heavily infested stands had an average mortality rate of 31 percent compared to 4 percent in uninfested stands.

The hemlock woolly adelgid is parthenogenetic (an all-female population with asexual reproduction) and has six stages of development (the egg, four nymphal instars, and the adult) and two generations a year on hemlock[1]. Each adult adelgid can produce between 50 to 300 eggs in its lifetime. Although mortality in HWA populations is commonly between 30 to 60 percent, the reproductive potential of this insect remains high. Adelgid mortality is generally attributed to three likely causes: 1) failure of first instars (crawlers) to find suitable hosts; 2) rapid temperature changes and/or an extended period of cold temperatures that coincides with a susceptible period of development for the adelgid; and 3) a sufficient loss in the nutritional quality and quantity of the food source, which leads to an increase in the proportion of the winged (sexuparae) form.

Adelgid feeding can kill a mature tree in about 5 to 7 years. This tiny insect (~ 1 mm) feeds on all age classes of hemlock, from seedlings to mature, old-growth trees.

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[1] The hemlock woolly adelgid also has a winged form, the sexuparae, which is produced by the spring generation. This form must complete part of its life cycle on spruce. The apparent lack of a suitable spruce host for this form in Eastern North America results in a substantial loss of adelgids each year

Dispersal and movement of HWA is associated with wind, birds, deer, and other forest-dwelling mammals. Humans also move the adelgid on infested nursery stock and during logging and recreational activities. Natural enemies capable of maintaining low-level HWA populations are nonexistent in North America.

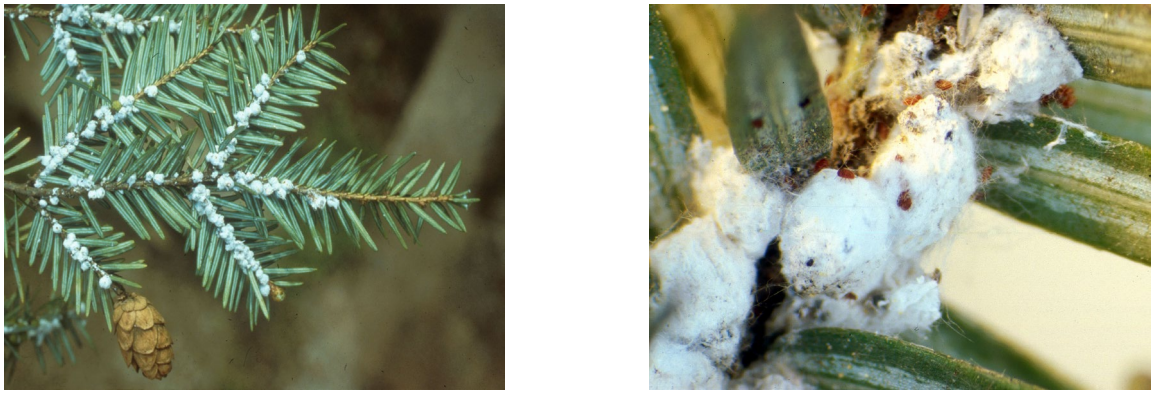

Figure 1. *Hemlock woolly adelgid on the underside of hemlock branches showing the woolly masses (ovisacs).*

HWA was first reported in the Western U.S. in the 1920s. HWA populations on western tree species, including western hemlock (*Tsuga heterophylla*) and mountain hemlock (*T. mertensiana*), appear to be innocuous; these tree species are believed to be resistant because little damage has been reported. Unfortunately, both tree species are of limited value for hybridization and planting due to their poor adaptation to the east coast environment. In the East, HWA was first reported in 1951 near Richmond, Virginia. It was initially considered to be largely an urban landscape pest and was controlled using a variety of insecticides applied with ground spraying equipment. Observations of the adelgid were periodically reported in several Mid-Atlantic States in the 1960s and 1970s but it was not until the 1980s that HWA populations began to surge and spread northward to New England at an alarming rate. By the late 1980s to early 1990s, infestations of HWA were reported to be causing extensive hemlock decline and tree mortality in hemlock forests throughout the East.

The purposes of this plan are:

- To provide a minimum detection threshold whereby HWA can be detected with 75 percent reliability in hemlock stands where at least 2 percent of the trees are infested.

- To make an efficient determination of the percentage of trees infested within a stand at the 0.25 precision level, the level commonly used for management purposes.

What to look for:

Look for the presence or absence of the white woolly masses (Figure 1) of HWA at the base of needles on the underside of hemlock branches. Hemlock woolly adelgids produce a white woolly coat that is easily observed because it contrasts with the hemlock foliage. It does NOT matter if the HWA are alive or dead. Counting is NOT required. HWA are specific in their appearance and location. If it doesn't look like a typical HWA white woolly mass, it probably isn't one. The number of HWA on a tree is lower when fewer trees are infested. So, if you're not finding anything, look closer.

Where to look:

Only select trees where branches can be reached from the ground. Examine the underside of the last meter of foliage on two branches that are on approximately opposite sides of the tree. If HWA is found on the first branch, do NOT examine the second branch. Although the sample branch must have some needles, do NOT discriminate in branch selection based on foliage quality.

How many trees to examine:

- A minimum of 15 but no more than 100 trees must be examined per stand for the presence or absence of HWA depending on how many positive trees are being found per stand.

How to look:

Identify the stand to survey from the maps included in this booklet. You will see that each stand has been broken into roughly four equal-sized blocks; the starting point (centroid) for each block is denoted by a point and its GPS coordinates (UTM 17 NAD 83). You do not need to be exact, just do the best you can.

1) Go to the first survey point you intend to sample and arbitrarily select your first tree to examine. Trees must have two branches that can be reached from the ground.
2) Select a branch and closely examine the underside of the terminal meter of foliage for the presence or absence of HWA white woolly masses at the base of hemlock needles. If HWA are found, mark the datasheet accordingly (in the "sum HWA trees" column, add a 1 for HWA present) and go to step 4.
3) If no HWA were found on the first branch, select a second branch on the opposite side of the tree and examine as before. Mark the datasheet (add 0 if no HWA found and add a 1 if HWA is present) and go to step 4. **NOTE: The data recorded is a running tally (sum) of the number of trees with HWA.**
4) Look at your datasheet to ascertain the random direction to follow to select the next tree. Pace out approximately 10 to 15 single-step paces in the direction indicated and select the closest tree with two branches that you can reach. Don't get carried away being too exact with your cardinal directions; it doesn't matter much, just shoot and go. The same goes for the distance to the next tree.
5) Examine the tree for HWA as in steps 2 and 3.

6) If HWA are detected, mark the datasheet by increasing the running tally by 1. If none were detected, re-enter the past tally number.
7) Repeat steps 4 to 6 until at least 15 trees are examined and a decision can be made based on the criteria below:
    a. If NO HWA were found, then repeat steps 4 to 6 until HWA are detected (go to b) or 25 trees are sampled (go to c), whichever comes first.
    b. If the running tally count is < the stop threshold, then repeat steps 4 to 6 until either the threshold is reached (go to e) or until 25 trees are sampled (go to c), whichever comes first.
    c. If the running tally count < the stop threshold, move to the next survey point and repeat steps 1 to 6. If the running tally count is still < the stop threshold after this sample, move to next sample point and continue sampling. If the stop threshold is reached at any point, go to e. Once all survey points have been sampled, go to d.
    d. If the running tally count < the stop threshold after 100 trees (all 4 locations) are sampled, STOP sampling.
    e. If the running tally count is $\geq$ the stop threshold, STOP surveying the stand.

If you encounter any situations or have any questions, give me a call at the office (304) 285-1544, cell (304) 376-2951, or at home (304) 594-3353.

Frequently asked questions:

- "I didn't find a tree at the end of the paces." Pick the closest suitable tree.
- "The plan says go northeast and there is a lake." Head in the opposite direction when you run into an obstruction, i.e., cliff, cow pasture, lawn.
- "The foliage quality is low and the needles are sparse." Sample it anyway; the poor quality might be due to HWA.
- "The stand ended." Head back into the stand.
- "There are no branches on the opposite side of the tree". Pick the branch farthest from the one already sampled.
- "How come it doesn't matter if the HWA are dead or alive?" It is very difficult to assess mortality without a microscope. For this reason, the sampling plan was developed without regard to survival status or stage of development. The presence of white woolly masses indicates that HWA have been and will probably continue to be in the area.
- "My GPS unit will not work" Use the map to get as close to the location as possible and the start survey.